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AN EVALUATION OF THE KIPP-KELLY AIR TABLE AS A GRAVITY CONCENTRATION TECHNIQUE FOR INDUSTRIAL MINERALS

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ABSTRACT

A 0.6 m x 1 m Kipp-Kelly air table was evaluated as a dry gravity concentration technique for the beneficiation of a variety of industrial mineral ore types. The study included the separation of barite from dolomite and quartz; of vermiculite from alumino silicates; of muscovite from quartz and feldspar; and the separation of halite from anhydrite.

Barite, vermiculite and muscovite were successfully concentrated; the success with vermiculite and muscovite demonstrated the influence of particle shape on concentration of these minerals. Halite was not significantly separated from anhydrite due possibly to the high = 93% feed grade of halite.

Keywords: Air Table, Gravity Concentration, Muscovite, Vermiculite, Barite

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ÉVALUATION DE LA TABLE PNEUMATIQUE KIPP-KELLY COMME MÉTHODE DE CONCENTRATION GRAVIMÉTRIQUE DE MINÉRAUX INDUSTRIELS

par

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RÉSUMÉ

On a évalué une table pneumatique Kipp-Kelly de 0,6 m x 1 m comme méthode de concentration gravimétrique à sec pour la valorisation de plusieurs minerais industriels. L'étude a porté entre autres sur la séparation de la barytine de la dolomite et du quartz, de la vermiculite des aluminosilicates, de la muscovite du quartz et du feldspath, et de l'halite de l'anhydrite.

Cette table a permis de concentrer la barytine, la vermiculite et la muscovite, mais dans le cas de la vermiculite et de la muscovite, la forme des particules influait sur l'efficacité de concentration. La séparation de l'halite de l'anhydrite n'était guère efficace, probablement en raison de la teneur élevée en halite ($\sim$ 93 %) de la charge de départ.

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INTRODUCTION

A Kipp-Kelly air table model ISY-100 complete with a No 2 -180+150 µm, linen covered, 0.6 m x 1 m deck and a metal covered deck were purchased by the Non-metallic Mineral Section in late 1983 from Spiroll Kipp-Kelly Ltd., Winnipeg, Manitoba.

DESCRIPTION AND PRINCIPLE OF OPERATION

The air float separator shares some features with the wet shaking table in that motion to the deck is imparted by a motor through a variable throw eccentric drive. The principal of stratified separation is similar but a greater sensitivity to slight differences in specific gravity of the particles is experienced when air is used as the separating medium than when water is used.

The feed material, as with feed to a wet shaking table, should be closely sized for efficient separation of minerals. Furthermore, it is important with air separation techniques that there be a minimum of fine dust with the feed.

The feed is fed across the surface of the reciprocating linen covered deck. Precisely controlled air, with respect to volume and pressure, is passed upward through the pores of the deck from a fan built into the table frame, with an air gate on the suction side of the fan. The air fluidizes the deck bed in such a way that the bed becomes stratified, with the heavier particles settling to the bottom and the lighter particles rising to the surface.

The influence of several parameters including feed rate, air pressure, air volume, oscillation speed, longitudinal and lateral deck slopes, specific gravity differential, particle shape and size, all combine to cause the heavier particles to settle and travel further along the deck. The heavier particles move in the direction of the deck motion and are discharged close to the narrow end, while the lighter particles are floated by air and travel laterally to the line of deck motion and are discharged at the wide or front end of the table, as shown in Fig. 1.

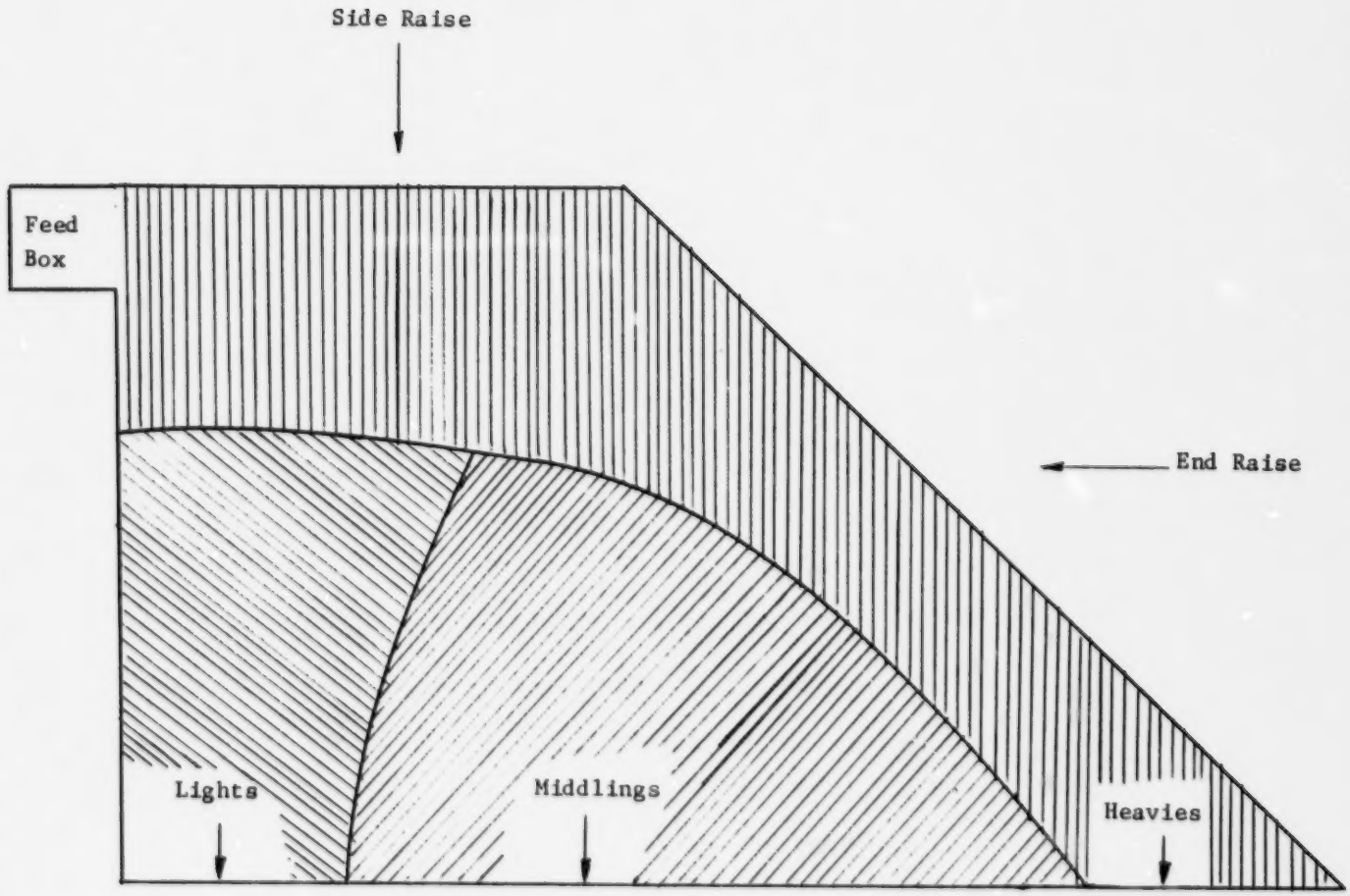

Fig. 1 - Normal deck load distribution of a product.

OPERATION

Detailed information concerning the control of operating parameters for the selective separation of minerals is outlined in the manufacturer's manual (1). These parameters are listed as follows:

1. Feed rate
2. Air volume
3. End raise (longitudinal)
4. Side raise (lateral)
5. Reciprocating speed
6. Eccentric stroke
7. Position of cutting fingers
8. Angle of toggles

To obtain a selective separation of concentrate from tailings, minerals will require careful control of most of these parameters. The usual procedure is to batch feed a sample and change parameters individually until optimum conditions have been obtained. While the influence of each parameter would require detailed discussion, the generalized effects of adjustments are listed as follows:

1. An increase in end raise will retard the climb of material up the deck and cause more material to discharge at the lower end.

2. An increase in side raise will cause more material to discharge at the lower end.

3. An increase in deck speed and an increase in eccentric throw will increase the rate of climb of material up the deck.

4. An increase in air volume will retard the rate of climb of material up the deck.

SCOPE OF STUDY

The two main parameters which have a greater influence in air classification than wet classification are particle shape and specific gravity differential. The purpose of this study therefore, was to ascertain to what degree these parameters could be utilised in separating those industrial minerals that exhibit a tendency towards either of these parameters.

MINERALS TESTED

1. A 1:1 by volume artificial mixture of barite and dolomite.

2. A barite ore containing ≈ 80% barite, 10% quartz with minor dolomite.

3. A vermiculite ore, containing ≈ 50% vermiculite.

4. A granite pegmatite, containing feldspar and quartz with minor muscovite.

5. A rock salt with approximately 7% anhydrite impurity.

RESULTS

A preliminary test was conducted on an artificial mixture of 50% barite and 50% dolomite, of size -2.5+0.6 mm to evaluate the effect of specific gravity on the separation of the two minerals. After adjustment of the principal operating parameters, a concentrate representing 78.9% recovery of barite with an S.G. of 4.4 was obtained; results are reported in Table 1. Subsequently a more representative barite ore of size -2.4+0.6 mm containing ≃10% quartz with minor dolomite was passed over the air table. The results reported in Table 2 indicate that 76.3% of the barite can be recovered in a concentrate of S.G. 4.32.

The effect of particle shape was evaluated in the recovery of both vermiculite and muscovite. A low grade = 50% vermiculite ore was concentrated on the air table in the -1.5+0.5 mm and -0.5+0.15 mm size fractions. The results reported in Table 3 indicate that in the -1.5+0.5 mm fraction, 93.9% recovery of the vermiculite in a concentrate analysing = 80% vermiculite was obtained. In the -0.5+0.15 mm fraction, 83.0% recovery of the veremiculite in a concentrate analysing = 65.0% vermiculite was obtained. Both tests gave excellent results, for while the -0.5+0.15 mm fraction produced a lower grade concentrate than the -1.5+0.5 mm fraction, the finer fraction had a higher ratio of concentration.

The effect of particle shape in recovering muscovite was assessed by concentrating muscovite from a typical granite pegmatite containing muscovite, feldspar and quartz. The ore was sized at -2+1.2 mm and -1.2+0.6. mm and each fraction was concentrated on the air table. The results reported in Table 4 indicate that in the -2+1.2 mm fraction, a concentrate analysing 86.2% muscovite was obtained; recovery, however, was low at 36.7%. In the -1.2+0.6 mm fraction a concentrate analysing 85.6% muscovite was obtained at a recovery of 91.6%. The low recovery with the -2+1.2 mm fraction is possibly due to the presence of muscovite-feldspar-quartz middlings. In each case it was demonstrated that a high grade muscovite concentrate could be obtained.

An attempt was made to separate rock salt (halite S.G. 2.2) from anhydrite (S.G. 2.9), but no significant separation was achieved. The possible reason for the lack of separation was the relatively high = 93% halite feed grade or the presence of anhydrite-halite middlings. It should be possible to separate these minerals because of the difference in S.G. and shape; halite has a characteristic cubic shape whereas, anhydrite is prismatic, tabular or lamellar.

CONCLUSIONS

1. Minerals with a wide difference in specific gravity can be separated selectively by air tabling.

2. Minerals with a marked difference in shape can be separated selectively by air tabling.

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REFERENCE

1. Anon. "Manufacturer's instruction manual: specific gravity separator", Kipp-Kelly Ltd., Winnipeg, Manitoba, (1981).

Table 1 Product balance for a 1:1 by volume mixture of -2.5+0.6 mm barite and dolomite

Products	Wt %	Volume %	S.G.	Distribution %
Concentrate	44	95	4.4	78.9
Tailings	56	20	3.1	21.1
Calculated head	100	53	3.7	100.0

Table 2 Product balance for a -2.4+0.6mm barite/quartz ore

Products	Wt %	S.G.	Analyses			Distribution		
			$BaSO_4$	SiO_2	[CaO+MgO]	$BaSO_4$	SiO_2	[CaO+MgO]
Concentrate 1	23	4.4	92.71	2.75	0.58	26.3	5.6	6.1
Concentrate 2	47	4.3	86.05	7.06	1.27	50.0	29.1	27.2
Tailings	30	3.7	63.92	24.88	4.88	23.7	65.3	66.7
Calculated head	100	4.1	80.94	11.42	2.19	100.0	100.0	100.0
Combined concs.	70	4.3	88.24	5.64	2.28	76.3	34.7	33.4

Table 3 Product balance for a -1.5+0.5 mm vermiculite ore

Product	Relative Wt %	Actual Wt %	Analysis %* Vermiculite	Distribution %	Ratio of Concentration
A. -1.5+0.5 mm					
Concentrate	56.3	39.6	80	93.9	1.14
Tailings	43.7	30.8	7	6.1	
Calculated head	100.0	70.4	34	100.0	
B. -0.5+0.15 mm					
Concentrate	57.1	16.9	65	83.0	2.20
Tailings	42.9	12.7	18	17.0	
Calculated head	100.0	29.6	13	100.0	
Combined concs.		56.5	77	90.8	
Combined heads			24		

*Visual Assessment

Table 4 Product balance for a -2+0.6 mm muscovite-feldspar ore

Product	Relative Wt %	Actual Wt %	Analysis % Musc*	Analysis $\%Al_2O_3$	Rel. Dist % Musc	Rel. Dist % Al_2O_3
A. -2+1.2 mm						
Concentrate	1.5	0.7	89	11.2	15.7	0.6
Middling 1	2.1	1.0	84	13.0	21.0	0.9
Middling 2	5.5	2.7	9	17.9	6.2	3.5
Tailing	90.9	43.9	5	29.8	57.1	95.0
Calculated head	100.0	48.3	8	28.5	100.0	100.0
Combined concs.		1.7	86		36.7	
B. -1.2+0.6 mm						
Concentrate	0.8	0.4	86	12.1	2.5	0.4
Middling 1	6.4	3.3	81	23.0	18.9	5.8
Middling 2	21.9	11.3	87	29.8	70.2	25.7
Tailing	70.9	36.7	3	24.4	8.4	68.2
Calculated head	100.0	51.7	27	25.4	100.0	100.0
Combined concn.		15.0	86		91.6	
Combined concs. (A+B)		16.7	86		79.4	

* Visual assessment by point counting under the microscope